INVITED CLINICAL COMMENTARY

MULTILIGAMENTOUS KNEE INJURIES – SURGICAL TREATMENT ALGORITHM

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ABSTRACT

The concept of multiligamentous knee injuries encompasses a large variety of presenting combinations, and the existing published literature lacks adequately sized prospective comparative patient-reported outcome studies to guide clinical decision making. The decisions of operative versus nonoperative management, timing of surgery, repair versus reconstruction, use of allograft versus autograft, choice of which ligaments to treat, and rehabilitation protocols remain controversial despite the fact that multiligament injuries have been shown to represent approximately 11-20% of knee ligament sprains presenting for treatment. For the purposes of this manuscript, a multiligamentous knee injury is defined as one complete cruciate tear (grade III) plus a partial or complete collateral tear (grade II or III) or a partial or complete tear of the other cruciate (grade II or III). A surgical treatment algorithm is proposed based upon a review of case series literature and clinical experience in an academic sports medicine practice setting. Use of our proposed surgical algorithms may facilitate clinical decision making in an attempt to restore stability, preserve function, and maximize return to activity.

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INTRODUCTION

The concept of multiligament knee injuries comprises a wide range of ligament and intra-articular injury patterns. These complicated injuries necessitate a methodical approach to evaluation and treatment. Management strategies for these multifaceted injuries attempt to balance the restoration of stability with maintenance of function through the mergence of operative and nonoperative means. The operative methods include repair, repair plus augmentation, or reconstruction of injured structures combined with bracing and rehabilitation in the short term. Nonoperative treatment is usually indicated for partial (grade II) ligament tears and occasionally for initial treatment in special circumstances. The ultimate goal of treatment is to return the patient to pre-injury employment or activity with the hope of delaying post-traumatic arthritis. The purpose of this manuscript is to 1) classify for the purposes of treatment for the spectrum of ligament tears included in the term "multiligamentous knee injury (MLKI)," 2) identify the reported incidence of these relatively infrequent injuries, and 3) propose a surgical treatment algorithm based upon the review of case series literature and clinical experience to assist decision-making when faced with this difficult problem.

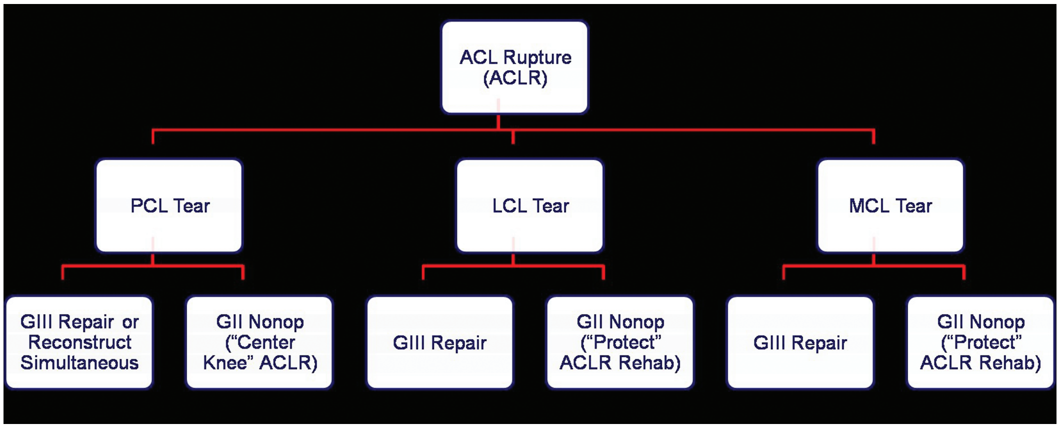

Figure 1. *Surgical algorithm is displayed for the patient that presents with an ACL tear with associated ligamentous injuries. ACL – anterior cruciate ligament, PCL – posterior cruciate ligament, LCL – lateral collateral ligament, MCL – medial collateral ligament, GII – grade II, GIII – grade III, Nonop - nonoperative*

DEFINITION

Prior to proposing an algorithm for surgical treatment, an attempt must be made to further define the subset of knee ligamentous injuries to be included for treatment. Review of the existing published literature reveals numerous descriptions of various treatment options for patients presenting with more than one ligament injury in the knee, but it is difficult to draw any firm conclusions from these studies due to small sample sizes, heterogeneous injury mechanisms and patterns, variable surgical techniques, inconsistent rehabilitation protocols, and lack of control groups or long term follow-up.[1-3]

For the purposes of this proposed treatment algorithm, the four major ligamentous stabilizers of the knee will be the anterior cruciate ligament (ACL), the posterior cruciate ligament (PCL), the medial collateral ligament (MCL), and the lateral collateral ligament (LCL), and a patient with MLKI will be defined as one complete cruciate tear (grade III) plus a partial or complete collateral tear (grade II or III) or a partial or complete tear of the other cruciate (grade II or III). Knee dislocations will be defined as complete tears of both cruciates (grade III) plus a complete collateral tear (grade III). Isolated single knee ligament tears will be excluded from this algorithm. The treating clinician should initially identify the most obvious presenting torn ligament, then, when recognizing an associated additional significant partial (grade II) or complete (grade III) ligament tear, follow the algorithm for ACL injury *(Figure 1)*, both cruciate ligament injury *(Figure 2)*, or either collateral ligament injury *(Figure 3)*.

INCIDENCE

Review of published studies analyzing incidence rates of patients with MLKI again reveals a heterogeneous mixture of patient populations, injury mechanisms, and criteria for inclusion making direct comparison essentially impossible. In a prospective cohort of 2,265 patients with knee injuries presenting to five established surgeons at three academic referral centers over an approximate 10 year period, only 11% involved patients with MLKIs. Of these patients with MLKIs, 70.5% involved the ACL and MCL making it the most common presenting pattern and 11.9% involved the ACL and LCL making it the second most common presenting pattern.[4] In a retrospective study of 9,749 skiing injuries compiled over 12 seasons at a Wyoming ski resort, 30% involved ligamentous knee injuries. Of these ligamentous knee injuries, combined lesions with specific attention directed towards concomitant ACL and MCL injuries, accounted for approximately 20% of the knee ligamentous sprains.[5]

TREATMENT

Optimal treatment of patients with MLKI remains controversial, and many factors must be taken into consideration when individualizing treatment protocols. Patient specific factors include age, preinjury activity level, medical comorbidities, motivation for rehabilitation, and expectations. Surgeon specific factors include open versus arthroscopic technique, choice of graft type (bone-patellar tendon-bone, hamstring tendon, quadriceps tendon, allograft Achilles tendon, and allograft tibialis tendon), potential neurovascular risks, experience with technique, and post-operative rehabilitation protocol. Injury specific factors include the degree of laxity, acute versus chronic presentation, high versus low energy mechanism, extra-articular injuries, concomitant meniscalor articular cartilage injury, limb alignment, and the potential for differential healing based upon the injury patterns for cruciates (avulsions versus midsubstance injuries) and collateral ligaments.

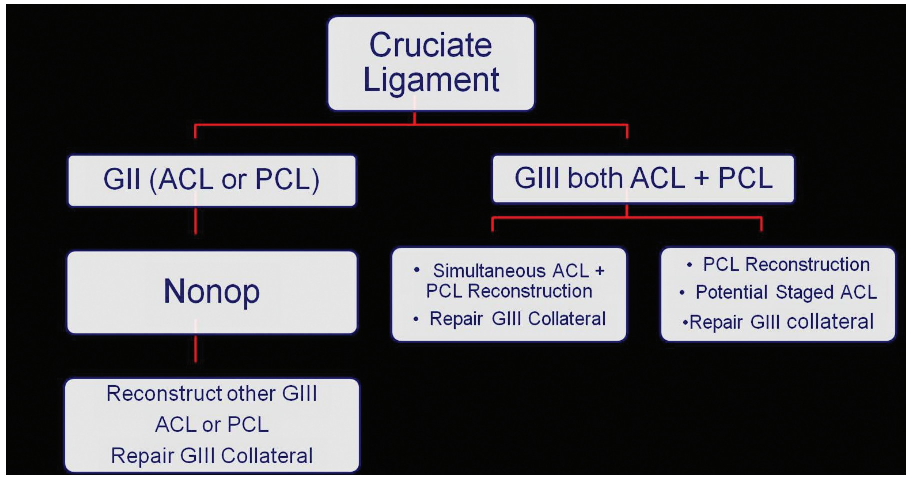

Figure 2. *Bicruciate surgical algorithm is presented for the patient displaying excessive anterior-posterior laxity indicating complete tear of one cruciate with injury to the other cruciate suspected. ACL – anterior cruciate ligament, PCL – posterior cruciate ligament, GII – grade II, GIII – grade III, Nonop - nonoperative*

Operative versus Nonoperative Treatment

In the past, treatment of the patient with MLKI consisted of inconsistent periods of immobilization in varying degrees of knee flexion. This method of treatment often led to mixed results due to the inverse correlation between length of immobilization and post-treatment motion. Longer periods of immobilization tended to result in a more stable knee with restricted active and passive range of motion, whereas, shorter periods resulted in more closely achieving normal motion but often with decreased stability. A meta-analysis of 15 case series comparing operative to nonoperative treatment revealed statistically significant improved patient-reported outcomes (Lysholm score of 85.2 versus 66.5), range of motion (123 degrees versus 108 degrees), and a decrease in the amount of flexion contracture (0.5 degrees versus 3.5 degrees) in the operatively treated group. However, no difference existed between the two groups regarding presence of instability, return to work, or return to pre-injury activity level.[6] The heterogeneous nature of the injuries and treatments included make interpretation of meta-analysis results relatively unreliable.

Despite the literature showing improved outcomes with operative treatment, nonoperative treatment remains a viable option in select situations.[7,8] These options include, but are not limited to, geriatric or inactive patients with co-morbidities that serve as contraindications to surgery as well as trauma patients unable to withstand additional systemic stress from operative intervention. In this setting, outcome expectations must be addressed at the beginning of the treatment period and surgical intervention, if possible, may have to be postponed until a later date in order to address potential instability or loss of motion should such impairments develop. This paper does not further address the nonoperative approach, but it should be remembered that the majority of significant partial tears (grade II) are treated nonoperatively. Thus, understanding how to protect partial tears from excessive forces during rehabilitation is important for avoiding excessive laxity.

Timing of Surgery

No consensus exists in the literature regarding the optimal time to proceed with surgical intervention.[3,9] Early surgery allows easier identification of anatomic landmarks and planes with the improved potential for direct repair of injured structures. However, arthroscopic fluid extravasation secondary to capsular injury may occur causing a compartment syndrome, and the risk of postoperative arthrofibrosis may be increased. Delaying surgery allows for decreased swelling, interval healing of the capsule and potentially the collateral ligaments, and increased range of motion. However, extensive scarring

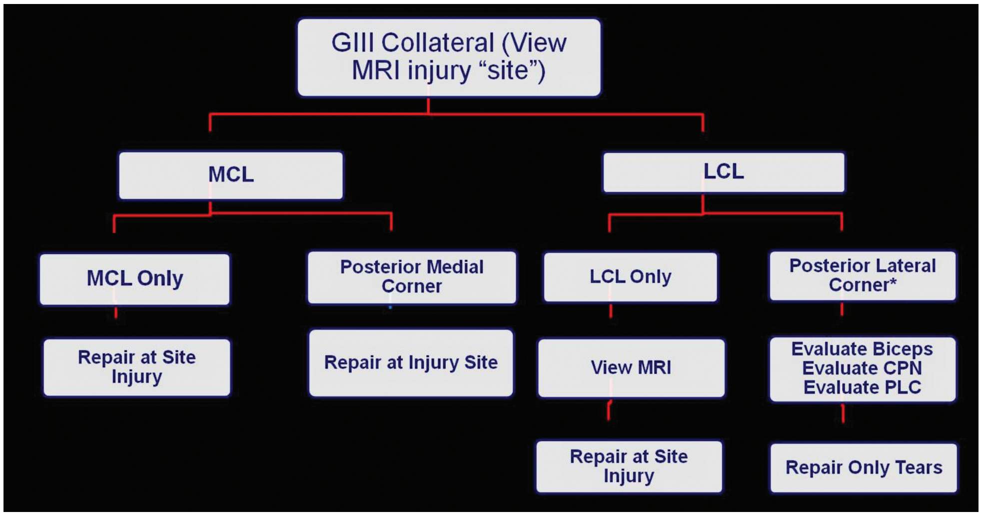

Figure 3. *Surgical algorithm is shown for the patient that presents with complete collateral ligament injury with excessive laxity at full extension indicating associated cruciate injury. MRI – magnetic resonance imaging, MCL – medial collateral ligament, LCL – lateral collateral ligament, GIII – grade III, CPN – common peroneal nerve, PLC – posterolateral corner*

with resultant loss of anatomic planes may occur contributing to the need for ligamentous augmentation or reconstruction. In general, delaying surgery for 10-14 days allows adequate time for decreased swelling with enough interval capsular healing to allow low pressure arthroscopic evaluation of the knee. During this delay, if initial magnetic resonance imaging (MRI) was not obtained, an MRI should be performed to further clarify the injured structures with attention focused upon the specific location of the injury. Each ligament should be carefully reviewed from femoral to tibial insertion for injury sites, and midsubstance versus bony avulsions at the tibia or femur should be noted. In addition, the MRI assessment of soft tissue and bony injury location has been shown to correlate well with intra-operative findings.[10] With delay of up to 21-28 days, direct repair of bony avulsions or midsubstance collateral ligament injuries can usually be performed, if necessary, with simultaneous arthroscopic treatment of intra-articular injuries and cruciate ligament reconstructions.[11]

Repair versus Reconstruction

Many factors influence the surgical treatment of each individual ligament injury, but specific attention should be focused upon the location of the primary injury site within each ligament and the length of time passed since initial injury. Regarding the location of the primary injury site within each ligament, midsubstance cruciate ligament tears (ACL, PCL), at present, are not amenable to repair regardless of the time passed since injury. Reconstruction is recommended in this setting. However, tibial or femoral-sided bone avulsions of the cruciate ligaments may be amenable to repair with screws or sutures. In general, primary repair of non-cruciate ligamentous injuries (MCL, LCL, and posteromedial or posterolateral corner) is a viable option if the surgery is performed within 21-28 days of the date of injury. Reconstruction should be considered if greater than 28 days has passed. In cases of repair, the need for augmentation must be individually assessed both clinically and through intraoperative examination. Thus, the surgeon should be prepared at the time of planned primary repair to be able to both augment as well as reconstruct if necessary. With this in mind, the surgeon should have allografts available and budget appropriate time for the case.

Allograft or Autograft

Choice of autograft versus allograft should be discussed with the patient before surgery with specific attention addressed to the advantages and disadvantages of each. Autografts can be harvested from the ipsilateral or contralateral extremity and include quadriceps tendon, hamstring tendon, or bone-patellar tendon-bone. Allografts allow for a far greater selection of tissues to include the aforementioned tissues as well as Achilles tendon, anterior tibialis tendon, or posterior tibialis tendon. Use of allografts eliminates donor site morbidity, decreases dissection time, can reduce the number of surgical incisions, and has the potential to reduce postoperative pain and stiffness. However, possible disadvantages include greater cost, the potential for disease transmission, and a delay in incorporation.

Ligament Options

The primary goals of treatment are restoration of stability, preservation of motion, and return of function, and each injury must be individually assessed in an attempt to best accomplish these goals. The decision of operative versus nonoperative management of each individual ligament injury is not always straightforward. For instance, an isolated PCL tear with associated 5mm of posterior tibial translation generally allows normal sports function without the need for operative intervention. On the other hand, an isolated ACL tear with 5mm of associated anterior tibial translation frequently leads to instability with sporting activities necessitating reconstruction. However, in the setting of a patient with MLKI, operatively addressing the PCL or collateral injuries and delaying ACL reconstruction can potentially lead to similar success rates with a lower risk of postoperative arthrofibrosis compared to addressing all ligamentous injuries at the same time, and subsequent ACL reconstruction is oftentimes not needed.[12] When taking all of these factors into account, it becomes easier to understand the difficulties associated with treatment decisions. This confusing clinical scenario, coupled with the lack of prospective comparative clinical outcome studies, led us to develop a surgical treatment algorithm for patients with MLKI.

If the patient presents with an ACL tear with associated ligamentous injuries, the approach is shown in Figure 1. In the setting of a grade III ACL tear with associated collateral or PCL injury, physical examination both preoperatively and under anesthesia is performed to determine if the associated ligament tear is complete (grade III) or incomplete (grade II). The difference between complete versus incomplete injury is defined by the presence or absence of significant abnormal laxity to valgus (MCL) or varus (LCL) stress when the knee is in full extension (zero degrees) and comparing to the contralateral normal knee. Since many patients with multiligamentous injuries may not be able to obtain full extension pre-operatively, the exam under anesthesia is a critical element to surgical decision making. If the associated injury is complete, the impairment should be addressed surgically at the time of ACL reconstruction. Correlating physical examination findings with MRI aids the surgical approach in identifying the site for repair of collateral ligaments. If the associated injury is incomplete, the patient may be treated with rehabilitation following ACL reconstruction.

If the patient presents with excessive anterior-posterior laxity indicating complete tear of one cruciate ligament and injury to the other cruciate ligament is suspected, the approach is shown in Figure 2. In the setting of injury to both cruciate ligaments, again an attempt must be made to differentiate between complete and incomplete injuries utilizing physical examination (preoperatively and under anesthesia), MRI, and arthroscopic evaluation. If both the ACL and PCL are determined to be completely disrupted (grade III), the PCL should be addressed surgically with either simultaneous ACL reconstruction or delayed ACL reconstruction in the future based upon predicted potential for ACL instability in activities of daily living. Any complete collateral ligament injuries should also be addressed operatively. In the setting of one complete cruciate ligament injury combined with an incomplete injury to the other cruciate ligament, the cruciate ligament with the complete injury should be addressed surgically with initial nonoperative treatment of the incompletely injured cruciate ligament. Again, complete collateral ligament injuries should be addressed operatively.

Not infrequently, the patient with MLKI presents with complete collateral ligament injury with excessive laxity at full extension. This finding should tip the examiner that a cruciate ligament is probably torn, and complete knee evaluation with MRI is indicated. Figure 3 outlines the approach to patients presenting with this scenario. In the setting of complete collateral ligament injuries, care must also be taken to evaluate the postero-medial corner and the postero-lateral corner of the knee. These injuries should also be addressed operatively as this impairment constitutes part of the spectrum of stability imparted by the collateral ligaments. It must be remembered that collateral ligament injuries frequently display interval healing during the time from injury to operative treatment. Therefore, the best time to assess the completeness of a collateral ligament injury is during the preoperative exam under anesthesia. If the tear is determined to be complete, operative treatment is recommended at the site of injury. The operative approach should be determined after reviewing the MRI to determine the location of injury. Careful review of preoperative imaging studies can limit the size and number of incisions needed to address pertinent pathology.

Published outcomes following treatment of patients with MLKI are mostly based upon procedural oriented studies and consist of case series. Results are surgeon dependent with variable rehabilitation protocols and no control groups. It is difficult to make comparisons amongst different techniques due to the broad number of procedures performed, the acute versus chronic nature of the injuries at the time of treatment, the combination of repair versus augmentation versus reconstruction methods, the use of allograft versus autograft, the presence of associated articular cartilage and meniscal injuries, and the lack of multivariable analysis. Thus, the approach presented represents interpretation of existing literature and experience with these complex injuries in an academic sports medicine practice setting.

REHABILITATION GUIDELINES

Postoperative rehabilitation guidelines must be individualized for each patient, and a multidisciplinary approach is vital for successful outcomes. Communication amongst the various treatment teams is the most important factor, and the surgeon and therapist must frequently re-evaluate the progress of each patient. As always, the rehabilitation plan should first be addressed preoperatively with the patient engaging in a discussion of expectations for return to activity and function.[13] This discussion should set realistic goals based upon the severity of initial injury.

The initial postoperative rehabilitation plan must take into account strength of fixation, balance the concerns for stiffness versus postoperative laxity, and provide protection when needed. The strength of fixation should be maximized intra-operatively by the surgeon and stability re-assessed while the patient is still under anesthesia. These findings should then be communicated to the therapy team. The presence of associated meniscal or articular cartilage injuries should also be communicated, as well as the plan for initial postoperative weight-bearing. In general, surgical treatment of PCL injuries requires a brief period of immobilization, and collateral ligament injuries require protective bracing. In cases of PCL or collateral ligament injury, weight-bearing is often delayed to allow more time for healing. In cases of ACL reconstruction, early motion generally results in a better outcome.[14] All of these factors must be taken into account with the need for ligament immobilization, protection, and motion balanced against each other for an individualized treatment plan.[15]

CONCLUSION

Multiligamentous knee injuries include a wide spectrum of pathology and represent a difficult clinical problem. A methodical approach must be implemented for each encountered injury pattern, and realistic goals must be established with the patient at the onset of intervention. Treatment remains controversial due to the lack of published high level evidence (prospective comparative clinical outcome studies), and results reported thus far are not patient-reported with validated outcomes. The decisions of operative versus nonoperative management, timing of surgery, repair versus reconstruction, use of allograft versus autograft, choice of which ligaments to treat, and rehabilitation protocols must be individualized to expected outcomes. Use of proposed surgical algorithms may facilitate clinical decision making in an attempt to restore stability, preserve function, and maximize return to activity.

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